BIOLOGY OF THE PENTATOMIDAE (HEMIPTERA)

BY

CHARLES ORRIS ESSELBAUGH

B. S., Ohio State University, 1923

M. S., Ohio State University, 1926

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ENTOMOLOGY
IN THE GRADUATE SCHOOL OF THE UNIVERSITY
OF ILLINOIS, 1945

URBANA, ILLINOIS

1945

BIOLOGY OF THE PENTATOMIDAE (HEMIPTERA)

BY

CHARLES ORRIS ESSELBAUGH

B. S., Ohio State University, 1923

M. S., Ohio State University, 1926

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ENTOMOLOGY
IN THE GRADUATE SCHOOL OF THE UNIVERSITY
OF ILLINOIS, 1945

URBANA, ILLINOIS

1945

Digitized by the Internet Archive
in 2026

https://archive.org/details/IA41549820_0069

INTRODUCTION

This thesis contains data on the life histories of twenty species of Pentatomidae, most of which are more or less prevalent in the vicinity of the University campus, as follows:

Euschistus variolarius P. de B.
Euschistus euschistoides Voll.
Euschistus tristigmus Say
Mormidea lugens Fab.
Hymenarcys aequalis Say
Coenus delius Say
Menecles insertus Say
Trichopepla semivittata Say
Neottiglossa sulcifrons Stal
Peribalus limbolarius Stal
Chlorochroa sayi Stal
Chlorochroa ligata Say
Chlorochroa persimilis Horv.
Thyanata custator Fab.
Cosmopepla bimaculata Thom.
Solubea pugnax Fab.
Acrosternum hilare Say
Brochymena sp.
Podisus maculiventris Say
Perillus bioculatus Fab.

Of the above species, two, viz. *Chlorochroa sayi* and *C. ligata*, have not been investigated by the writer, all information having been obtained from published literature. The remaining species have been investigated in varying degrees by the present writer and the information so obtained is supplemented by published data.

In order to obtain the new data it has been necessary to rear the various species through all the life stages whenever possible. Due to the lack of an insectary it has been necessary to do all rearing under indoor conditions. The methods employed do not differ greatly from those of other investigators who have worked on similar problems, the principal modifications being with regard to food material suitable for the species and the selecting or designing of appropriate cages for the rearing. The principal types of cages are described and illustrated and the food supplied to the various species is indicated.

SEASONAL LIFE HISTORY

Overwintering.

Hibernation in the adult stage seems to be almost universal in this family but accounts indicate at least two species of the genus *Apateticus* overwinter in the egg stage. Nymphs of most

species are present in the field at the close of the growing season and, although they take to cover in the same manner as do the adults, those of the American species are, so far as known, unable to hibernate successfully, seldom surviving the first severe frost. Those species found in hibernation by the writer have almost invariably been beneath fallen leaves, etc., in actual contact with the soil but some other writers report finding certain species among the leaves or inside curled-up leaves and under rubbish such as boards, stones, etc.

It seems to be generally considered by the various investigators that in the Pentatomidae only sexually undeveloped individuals hibernate and it is usually intimated that these are newly matured individuals, or at least of the last generation, but this seems capable of contradiction in some cases, Knight (1922) recording gravid females of *Perillus bioculatus* as hibernating successfully. Most but not all species enter hibernation at the advent of cold weather and remain dormant until the approach of spring. At least one instance is known in which hibernating adults become sufficiently active during mild periods in midwinter to emerge and feed upon the sap from tender shoots of woody perennials.

Mating.

Upon emergence in the spring, the adult insects are at first quite sluggish. They crawl up on something, preferably foliage, and spend some days basking in the warming rays of the sun. Acceptable food may not yet be available but mating usually begins during this time. In some species whose mating habits are known, mating occurs repeatedly and may continue without interruption for as long as forty-eight hours. The adults are polygamous and polyandric. In species having two or more generations annually, adults of the non-overwintering generations may mate at any time from a few hours to a few weeks following the final molt.

Oviposition.

Upon mating, varying lengths of time are required for sexual development of the female and subsequent oviposition. Usually

the time required is from one to three or four weeks, the first being the more common. Oviposition by overwintering generations, therefore, begins in the spring, probably during early May for most species in this latitude, and continues through June in most instances, and some even longer. Multiple generations complicate this considerably, the oviposition periods of the various generations interlocking and giving rise to continuous oviposition until the arrival of cold weather. One notable exception to this rule is the predaceous species, *Perillus bioculatus*, which apparently goes into hibernation or aestivation when its principal food, the Colorado potato beetle, disappears, which here is about the middle of August.

The eggs of the Pentatomidae are not deposited singly except in abnormal cases. Under normal conditions each egg is stood on end and is cemented to the substratum and to adjoining eggs by a secretion from the mother. In most species the eggs are aligned in astonishingly straight rows, the eggs in adjoining rows so alternated as to fit into the interstices of the other row. The number of eggs and the number of rows vary within moderate limits but on the whole are quite characteristic for the species. Probably most species deposit their eggs on the under side of foliage but many others utilize the upper surface and still others small stems and leaf petioles, not to mention occasional masses on fruits and flowers.

The eggs of all the species studied, while varying to a considerable degree, have certain features which unmistakably characterize the group, the principal one being the circular operculum at the uppermost end, surrounded by a ring of tubular chorionic processes whose size and form are uniform for the species. The eggs are more or less cylindrical in form, usually with rounded ends, and the chorion may contain either spines or depressions in addition to the processes already mentioned.

Incubation.

The time required for incubation, at a given temperature, does not vary widely within the group (if one excludes the overwintering eggs of *Apateticus*), usually being from three to six days under midsummer conditions but requiring a day or two longer during May and September.

The transparent chorion of the eggs of most species makes it possible to detect, to some extent, the development of the embryo. The eyes and certain other markings are usually some shade of red and the egg-burster a thin black crescent. In most species these can be seen to move the last day or two before hatching. At the time of hatching the operculum is forced open by the egg-burster, a chitinous structure uniformly present in this family and in the Scutelleridae. Usually a small section of the perimeter of the operculum remains attached to the egg as though hinged but probably persists only because not subjected to any tearing action at that point.

Nymphal Development.

In those species whose life histories are known, the nymphal period consists of five instars. In general the variations between species in time required for the different instars and in the nature of the changes taking place during instars are not great. The first instar is invariably the shortest in point of time and the fifth the longest, the intervening three being somewhat variable in this respect, the average of the five being usually about equal to the incubation period.

Throughout the first two instars the nymphs are markedly gregarious and even the shed nymphal skins are usually found in close proximity to each other but thereafter a nymph about to molt usually seeks seclusion. The nymph sets its tarsal claws firmly into the substratum. The old skin first splits along the median line of the notum, then along the frontal sutures of the head, allowing the latter to be withdrawn. The appendages and abdomen are withdrawn without rupturing the old skin, the tarsal claws remaining attached to the substratum.

Number of Generations.

The number of generations produced annually by a given species frequently varies with the length of the growing season but not necessarily so. A number of the species produce only one generation under climatic conditions prevailing in central Illinois, while others seem to produce as many as three or even a partial fourth, with all gradations in between. There are nymphs of most species in the field up to the time of the first

killing frost, but a few distinctly single-brooded species complete their development rather early and do not mate until the following spring.

FEEDING HABITS

First instar nymphs in most cases do not feed, the alimentary tract being crammed with sufficient yolk to make feeding unnecessary. The food of the other instars is in general the same as that of the adults, with whom they are frequently found feeding. The nymphs do not feed either immediately preceding or immediately following a molt.

As regards the nature of the food utilized, the family must be divided into two categories, viz. phytophagous and predaceous. The plant feeders are considerably in the majority but few have attained the status of economic pests. Being sucking insects, the food consists of the fluid interior of various plants and plant parts. While phytosuccivorous forms are usually regarded as consumers of sap from the vascular system, a surprising number of Pentatomidae show a preference for the starchy interior of seeds while it is yet in the milk stage and many others attack the fleshy pericarp of various berries and other types of fruits.

In feeding, a considerable amount of fluid may be extracted from a single puncture of the epidermis. It is said by some authors that the salivary secretion is capable of breaking down cell walls. This has not been investigated by the present writer but direct observation leads to the conclusion that the cell walls are actually broken down mechanically before any but extreme chemical action would be able to accomplish it. This is accomplished by piercing the intervening cell walls with the maxillary setae, which dart rapidly back and forth through the tissues in a manner strongly suggestive of a snake's tongue.

Those species which confine their feeding to the vascular system of the plant seldom cause much direct damage. In severe cases the plant may wilt but usually only temporarily. Of considerably more importance is the occasional damage caused by fungi which may be introduced through the feeding punctures. This latter menace also applies to those which feed upon fruits and seeds but here the direct damage may also be considerable, frequently resulting in a high percentage of shriveled and non-

viable seeds and cereal grains and unmarketable fruits. A different form of indirect damage from that mentioned may also result when fruits are fed upon during the earlier stages of growth, resulting in malformation of the fruits and referred to as "cat-facing".

One section of the family, comprising the subfamily Asopinae, is, so far as known, predaceous and the species are quite well adapted to this mode of life. The morphological adaptation in this instance consists of a rostrum which is not only more strongly constructed but much more mobile than that of the phytophagous forms. The principal food of these predators consists of eggs of other insects, naked larvae of various kinds and to a lesser extent the other life stages. The second instar nymphs are usually obliged to rely upon eggs for food but thereafter attack increasingly larger prey. Most of those whose food habits are known are non-specific in their choice of food but their limitations are such that they do not seem to offer any serious menace to our beneficial insect species, the principal exception being the frequent habit of preying upon their own kind.

EVOLUTIONARY TRENDS.

A study of the egg structure seems to indicate a quite different evolutionary development than that which has generally been accepted by taxonomists. This study has for the present been confined to the tribe Pentatomini, which includes seventeen of the species treated in the paper. The relationships indicated in this study follow rather closely an arrangement used by Blatchley (1926), but who himself considered it highly artificial and used it only for convenience. To what extent these conflicting sets of data can be rationalized has not been determined.

SUMMARY.

The summary of the findings relative to life history are included in the accompanying table (Table 1), which is intended to be largely self-explanatory. The data concerning three species, viz. the two species of *Chlorochroa* already referred to and *Nezara viridula* are derived from published literature and rearranged to conform so far as possible with the method of presentation followed for the other species.

SUMMARY OF LIFE HISTORY DATA

Species	No. gen.	Number eggs per mass	Duration of Immature Stages in Days						Total of immature stages	Food
			Egg	First instar	Second instar	Third instar	Fourth instar	Fifth instar		
Euschistus variolarius	1+	5-40 Av.18.4	3-9 Av.5.6	2-11 Av.3.5	4-16 Av.7.5	5-17 Av.7.9	5-13 Av.7.7	8-16 Av.10.0	36-49 Av.42.2	Vasc. Fruits
Euschistus euschistoides	?	8-55 Av.21.7	3-9 Av.6.0	2-9 Av.3.4	4-12 Av.8.3	2-14 Av.8.2	4-16 Av.9.9	7-20 Av.12.0	36-82 Av.47.8	Vasc. Fruits
Euschistus tristigmus	2+	1-28 Av.13.6	3-10 Av.6.3	2-6 Av.3.8	3-16 Av.8.7	3-15 Av.7.7	4-23 Av.8.8	7-22 Av.11.9	28-63 Av.46.2	Vasc. Fruits
Mormidea lugens	?	7-20 Av.10.2	4-7 Av.4.9	2-4 Av.3.0	-	-	-	-	-	Vasc. ?
Hymenarcys aequalis	?	4-13 Av.8.2	4.5 Av.4.3	1.5-3.5 Av. 2.1	-	-	-	-	-	Vasc. ?
Coenus delius	1	1-20 Av.7.3	3-6 Av.4.8	3-4 Av.3.2	6-10 Av.7.8	9-12 Av.10.5	-	-	-	Vasc. Seeds
Menecles insertus	?	10-13 Av.11.3	4-6 Av.5.3	2-3 Av.2.7	6 -	11 -	9 -	-	-	?
Trichopepla semivittata	2 ?	4-28 Av.12.4	4-7 Av.5.5	3-6 Av.4.1	3-7 Av.5.4	3-5 Av.4.1	4-6 Av.5.2	12-19 Av.17.0	33-43 Av.40.0	Seeds
Neottiglossa sulcifrons	?	2-9 Av.5.8	3 Av.3.0	2-4 Av.3.0	-	-	-	-	-	?
Peribalus limbolarius	2 + (?)	2-28 Av.15.0	3-6 Av.4.1	1-6 Av.2.7	2-13 Av.4.2	2-9 Av.6.6	9-12 Av.11.2	16 -	44.8 -	Seeds Vasc.
Chlorochroa sayi	3+	-60 Av. 25	5-7 Av. ?	5 Av.5.0	7-9 Av.8.2	5-7 Av.6.4	7-10 Av.8.2	13-17 Av.14.9	-	Seeds
Chlorochroa ligata	?	-79 Av.28.4	3-7 Av.5.2	4-5 Av.4.5	5-7 Av.6.0	6-10 Av.8.0	5-12 Av.8.0	7-17 Av.12.0	Av.43.7	Fruits Seeds
Chlorochroa persimilis	2 ?	3-43 Av.21.3	3-6 Av.4.8	2-12 Av.3.5	5-11 Av.7.6	5 -	9 -	21 -	49.6 -	Fruits
Thyanata custator	2 ?	8-72 Av.35.4	3-8 Av.4.5	2-8 Av.3.8	3-11 Av.6.9	6-17 Av.8.3	8-12 Av.9.8	7-16 Av.12.0	38-47 Av.45.3	Fruits Seeds ?
Cosmopepla bimaculata	3 ?	2-24 Av.11.3	3-8 Av.4.6	1-10 Av.2.7	3-14 Av.8.3	4-11 Av.6.8	6-21 Av.7.9	7-16 Av.10.3	33-46 Av.40.6	Vasc.
Solubea pugnax	?	8-44 Av.25.7	4-8 Av.5.2	2-4 Av.2.7	3-11 Av.5.0	3-12 Av.5.4	3-12 Av.6.3	6-15 Av.9.9	28-40 Av.34.5	Seeds
Acrosternum hilare	1	9-69 Av.29.8	4-8 Av.6.3	3-6 Av.4.0	5-16 Av.7.3	3-13 Av.9.0	8-28 Av.10.6	16-27 Av.21.5	54-81 Av.58.7	Fruits Vasc.
Nezara viridula	?	60-116 Av. ?	4-5 Av.4.5	3 Av.3.0	3-13 Av.6.9	1-11 Av.5.2	4-12 Av.7.3	3-19 Av.9.4	- Av.36.3	Fruits Vasc.
Podisus maculiventris	3?	5-62 Av.24.7	2-7 Av.4.6	3-5 Av.3.4	3-7 Av.4.7	3-5 Av.4.0	3-6 Av.4.4	4-7 Av.6.1	19-29 Av.27.2	Pred.
Perillus bioculatus	2-3	7-32 Av.16.6	3-7 Av.4.4	1-4 Av.2.2	1-4 Av.2.6	1-4 Av.3.5	2-5 Av.3.1	3-8 Av.5.4	16-23 Av.21.2	Pred.

Table 1.

The data contained in the column concerning the number of generations is in most cases somewhat uncertain but, except for the three species just referred to, are to be construed as applying to local conditions. The column concerning the source of the food is based on rather meager observations and probably gives a rather incomplete picture. Much of it is based on laboratory observations and may even represent food not ordinarily utilized by that species. The abbreviation "vasc." refers to vascular tissue as the part attacked.

VITA

Charles O. Esselbaugh was born November 26, 1898, near Fostoria, Ohio. His grammar school education was obtained in a one-room rural school near Fostoria and his high school education at Fostoria High School, graduating in June, 1916. He entered Ohio State University, in the College of Agriculture, in the war year of 1918 and enlisted in the S. A. T. C. unit there, dropping out after the disbanding of the military unit and reentering in 1919. During the following four years he majored in Agricultural Engineering and graduated, with the degree of Bachelor of Science in Agriculture, in 1923. During the school year of 1923-24 he taught in Bradner (Ohio) High School then returnind to the above University to enter the Graduate School, from which he received the degree of Master of Science in March, 1926. His Master's thesis concerns the heat treatment of stored grain insects and its effect on the viability of the seed. Following graduation he returned to teaching, in Mansfield (Ohio) High School in 1926-27 and as high school teacher and supervising principal in the Grafton (Ohio) Village School from 1927-30. The summer of 1930 was spent at the Franz Theodore Stone Laboratory in Lake Erie, after which he returned to the Ohio State University campus to continue graduate work. Alternating with periods of graduate work, he worked for the Ohio Agricultural Experiment Station on the European corn borer, the oriental fruit moth (under the U. S. Bureau of Entomology) at Vincennes, Indiana, and the white pine blister rust in Vinton and Knox counties in Ohio. In January, 1934, he started working on the Dutch Elm Disease project in East Orange, New Jersey, under the auspices of the U. S. Bureau of Entomology and Plant Quarantine. He continued this work until the close of the year 1941, the majority of the time serving in the capacity of Agent. Much of this period the duties were supervisory but a considerable amount of time was also spent in making of extensive surveys.

He entered the University of Illinois, as a graduate student, in February, 1942. He is a member of the American Association of Economic Entomologists and the Entomological Society of America.